PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

JUN 22 1931

The Journal of HEREDITY

Joseph Lancaster Budd
First Professor of Plant Breeding

Palm-Prints of Twins

Inheritance of Rust Resistance

A Hen That Twice Changed Color

VOLUME 22 FEBRUARY, 1931 NUMBER 2

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President Vice-President, W. E. CASTLE Secretary, C. E. LEIGHTY

Treasurer, MRS G. W. SINCELL

JOHN B. LARNER, Financial Advisor Legal Advisors, PEELLE, OGILBY and LESH

EDITORIAL BOARD

Managing Editor: ROBERT C. COOK

M. DEMEREC R. R. GRAVES L. C. DUNN

H. J. MULLER GEORGE M. DARROW PAUL POPENOE

Members of the Council are ex-officio members of the Editorial Board

COUNCIL

W. E. CASTLE, Professor of Zoology, Harvard University, and Research Associate of the Carnegie Institution of Washington.

LEON J. COLE, Professor of Genetics, University of Wisconsin.

G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.

O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.

DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.

HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.

SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.

C. E. LEIGHTY, Agronomist in Charge of Eastern Wheat Investigations, U. S. Department of Agriculture.

VERNON KELLOGG, Permanent Secretary, National Research Council, Washington, D. C.

J. H. KEMPTON, Bureau of Plant Industry, U. S Department of Agriculture.

E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.

A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.

J. K. BREITENBECHER, McGill University, Montreal, Canada.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.

J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.

RUSSELL W. DUCK, Professor of Animal Husbandry, Syracuse University, Syracuse, New York.

E. M. EAST, Professor of Plant Genetics, Bussey Inst. of Applied Biology, Boston, Mass.

R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.

F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhatten, Kansas.

MRS. CHARLES C. RUMSEY, Wheatly Hills, Westbury, Long Island.

JOHN M. SCOTT, Vice Director, Florida Agricultural Experiment Station, Gainesville, Florida.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Pomologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

CHARLES R. STOCKARD, Professor of Anatomy, Cornell University, New York City.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.

LOU D. SWEET, Seedsman, Denver, Colorado.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.

H. J. WEBBER, Director, Citrus Experiment Station, Riverside, California.

E. N. WENTWORTH, Armour's Bureau of Agr'l Research and Economics, Chicago, Illinois.

P. W. WHITING, Department of Biology, University of Pittsburgh, Pittsburgh, Pa.

The

Journal of Heredity

Vol. XXII FEBRUARY, 1931 No. 2

IN THIS ISSUE

PALM-PRINT PATTERNS IN TWINS
By H. H. Newman 41

INHERITANCE OF SMUT RESISTANCE AND JUICINESS OF STALK IN THE SORGHUM CROSS, RED AMBER × FETERITA
By Arthur F. Swanson and John H. Parker 51

A HEN WITH VARIABLE PLUMAGE
By C. B. Godbey and D. H. Reid 59

REVERSE GENE-VARIATIONS IN DROSOPHILA
By N. W. Timofeff-Ressovsky 67

THE HUMAN CONSTITUTION (Rev.)
By Walter Landauer 49

DISEASES OF PLANTS 50

BOOKS RECEIVED 56

URBAN AND RURAL BIRTHRATES 58

HEREDITY AGAIN RECOGNIZED BY LAW 63

HOW WE GROW UP 64

JOSEPH LANCASTER BUDD 66

R. A. FISHER TO VISIT U. S. 66

COMING

Is England Approaching Depopulation?

Four-Ounce Eggs From Manchuria

Why Are Siamese Twins Unlike?

The Harness Race Horse in America

A Broken-Boned Family

Bud Variations in the Bartlett Pear

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION, at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1931 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$3.50 a Year *Prices of back numbers on application* ***35c. the Copy***

FINGERPRINT PATTERN SIMILARITIES

Frontispiece

Finger prints of corresponding fingers of three pairs of identical twins. Such degrees of correspondence as between the pair shown at the left are quite common among identical twins and are not found at all among fraternal twins. While finger prints of identical twins are never really identical, they show extraordinary correspondences that could hardly be present in two individuals not genetically the same.

PALM-PRINT PATTERNS IN TWINS

On the Use of Dermatoglyphics as an Aid in the Diagnosis of Monozygotic and Dizygotic Twins

H. H. Newman
University of Chicago

THE present paper was prompted by a recent article by Professor Cummins[1] on *Dermatoglyphics in twins of known chorionic history, with reference to diagnosis of the twin varieties.* It seems to the writer that Cummins' paper may leave a wrong impression in that it tends to minimize the value of dermatoglyphics, Cummins' own favorite subject, as an aid in twin diagnosis. Hence it may be worth while to indicate clearly just what the writer conceives to be the value of dermatoglyphics in this field and just how twin specialists use this material.

The material used by Cummins comprised the palm and sole prints of eight pairs of twins, whose fetal membranes had been diagnosed by a competent worker as monochorionic or dichorionic. Without knowing anything whatever about these twins beyond what he could read in the prints of palms and soles, Cummins attempted a diagnosis of their origin—whether monozygotic or dizygotic. His diagnoses, when compared with the report on fetal membranes, showed two discrepancies out of eight cases. There was agreement in the other six. Cases III and VII were diagnosed as monochorionic by the obstetrician, but as dizygotic by Cummins. These discrepancies, together with other facts to be discussed later, are made the basis of a general skeptical attitude concerning the value of dermatoglyphics in diagnosing zygosity in twins.

After a very careful objective comparison of all elements in both palm and sole patterns in the eight pairs of twins Cummins ranked them in the order of degrees of resemblance, first according to qualitative differences, and second to quantitative differences. The arrangement, running from most similar to least similar (using the letters M and D to indicate the mono- and dichorial character of the pairs), was for quantitative differences as follows: I(M), V(D), II(D), VIII(M), VII(M), III(M), IV(D), VI(D). For qualitative differences the following somewhat different order of resemblance is given: V(D), I(M), VIII(M), III(M), II(D), VII(M), IV(D), VI(D).

The most significant points here are that pair V, a dichorial pair, ranks either first or second in resemblance; that pair II, another dichorial pair, ranks third and fifth, averaging as high as some of the monochorials; that IV and VI, both dichorials, rank at the bottom of the list as might be expected; and that monochorials are scattered from first to sixth, but are never lower. It seems rather surprising that pair V, a dichorial pair (here assumed to be dizygotic and therefore genetically unlike) should rank among the most similar in dermatoglyphics.

Cummins concludes that: "Neither the ranking of the twin pairs according to the degree of total differences nor the ranking of bilateral differences leads to an assortment by which the monochorionic and dichorionic twins are separated. The conclusion is therefore forcefully presented that the dermatoglyphics, as here analyzed at least and in this series, fails to supply a secure basis for the diagnosis of individual pairs of twins."

The Unreliability of Fetal Membranes as Criteria for the Diagnosis of Twins

For some time investigators of human twins have felt so uncertain about the real nature and origin of human fetal membranes that they have ceased to rely on them as criteria for the diagnosis of zygosity. Such careful and capable students of human twins as

Siemens, v. Verscheur, and Dahlberg have been forced to rely exclusively upon the similarity method of diagnosis and to give only very secondary consideration to fetal membranes. The recent work of Fr. Curtius[2] represents the attitude of the best of the European students of twins.

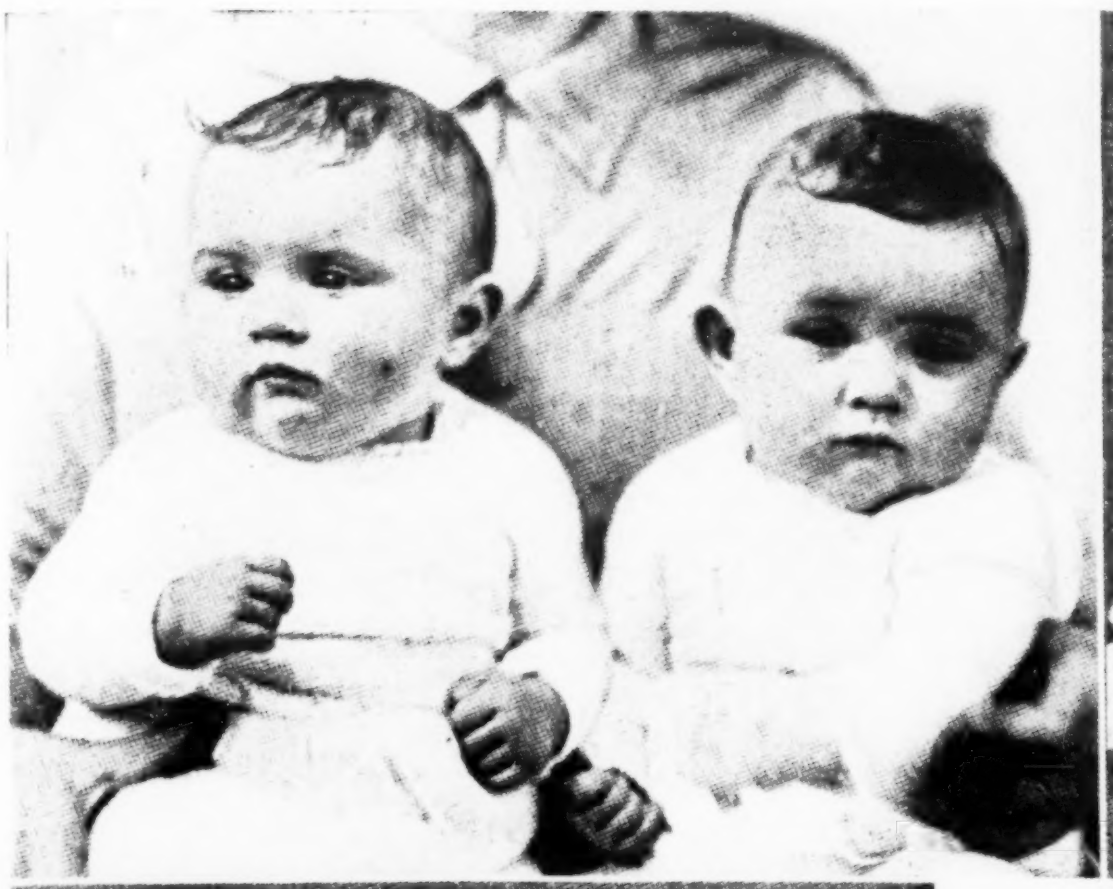
Curtius points out that in spite of the many-sided application of the twin method of research in the study of human heredity, our knowledge concerning the development of the embryonic membranes and placentae in twins is extremely inadequate. The result is that we are very poorly equipped to diagnose the zygotic origin of twins by examination of afterbirths.

It is generally assumed that all monochorial twins are monozygotic and ali dichorial twins are dizygotic. But both Siemens and Verscheur, highly competent experts in the field of human twinning, have found exceptions to this rule, and recently Curtius has found what he claims to be three remarkable exceptions. He collected from the maternity clinics of several hospitals 56 cases of twins in which the membranes had been adequately registered. Of these, 12 were opposite-sexed pairs and 44 same-sexed. As many of these cases as could be located were followed up years later, and were given careful examination at the Kaiser Wilhelm Institute of Anthropology, using the method of Siemens and Verscheur. Only 19 of the surviving 31 cases of same-sexed twins were available for study. Twelve of these same-sexed pairs, on the basis of the similarity test, were diagnosed as dizygotic, as were of course the 12 opposite-sexed pairs. All of these 24 cases turned out to be dichorial. But of the 7 pairs diagnosed by the similarity test as monozygotic, 3 were monochorial, 3 dichorial, and 1 doubtful because of poor condition of the afterbirth.

The remarkable feature of this study is that nearly half of the most strikingly similar twins were dichorial. This finding is likely to be very disturbing to students of twins, especially to those claiming some knowledge of human embryology. Such a condition would seem to imply that in these cases at least, the twinning division occurred prior to the trophoblast and inner-celi-mass stage, that is, during early or middle cleavage. Of course there is nothing impossible about this. Indeed there is considerable evidence that, in man, the period at which twinning takes place is highly variable, and there is no *a priori* reason why it may not extend back even to the four- or eight-cell stage. It could not occur at the two-cell stage because, as Sabotta has shown, the first cleavage is not equational.

After examining the photographs (Figure 1) and the detailed resemblances of the three alleged monozygotic dichorial twins as presented by Curtius, there can be no doubt as to their being monozygotic, for they are all three of the most strikingly identical type. It is not for us to pass judgment as to the correctness of the membrane registrations. One inadvertent mistake might conceivably have crept in, but the probabilities are all against three such mistakes all of the same sort being made, and none of the other sort being made (involving registering a dichorial condition as monochorial, mistakes much more easily made because of secondary fusions of adjacent chorions.) Moreover, the fact that there was complete agreement between membrane diagnosis and similarity diagnosis in 24 pairs diagnosed as dizygotic speaks well for the accuracy of the membrane diagnosis and leaves us no alternative but to accept the statement that monozygotic twins are sometimes, probably not infrequently, dichorial.

This being the case, it may well be that Cummins' pair V, about the most similar of the eight pairs, was monozygotic, though dichorial. Apart from this case there is no real discrepancy in the rest of the list. Monozygotic twins frequently show rather surprising differences in dermatoglyphics,



DICHORIAL IDENTICAL TWINS

Figure 1

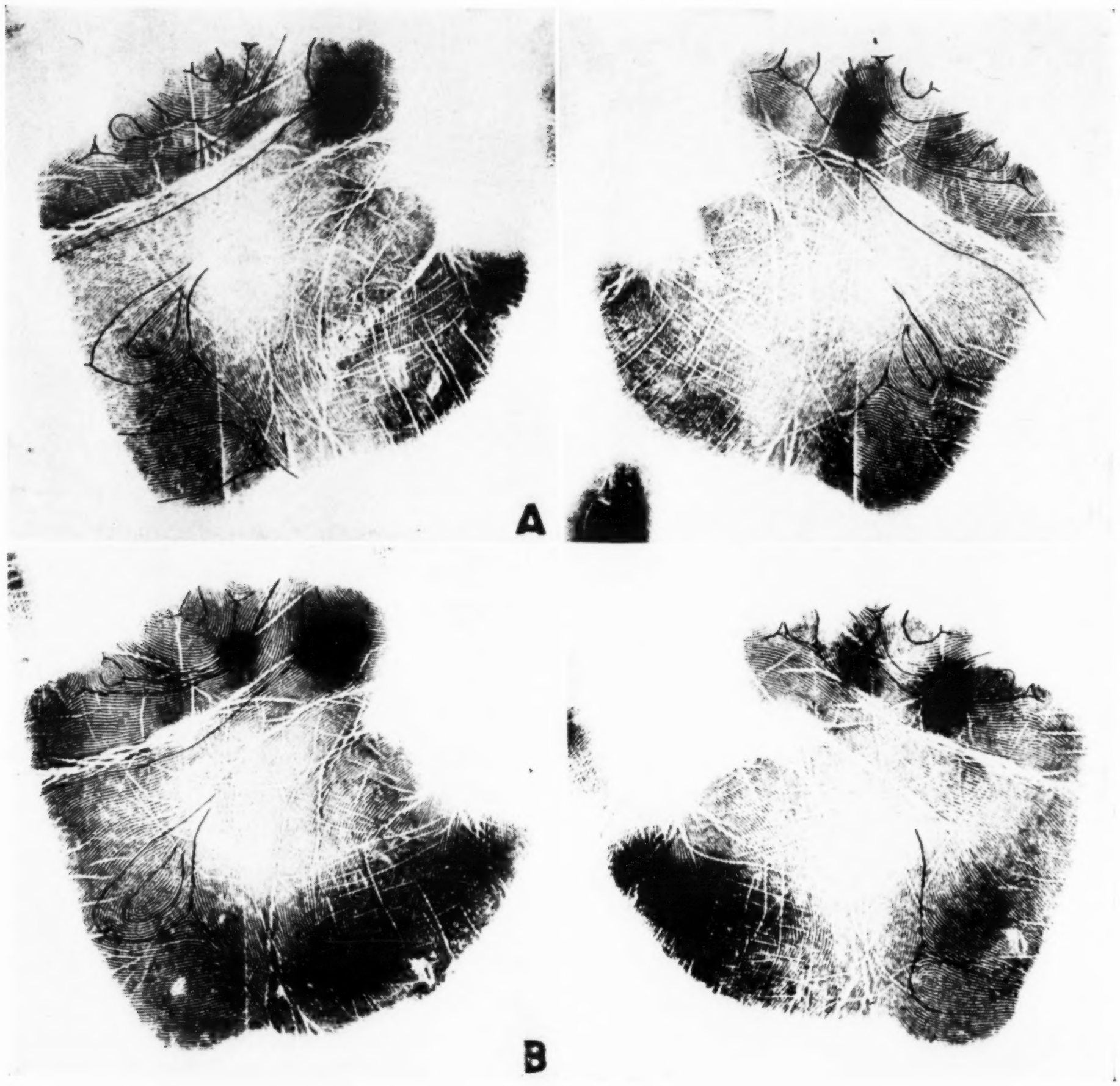
Three pairs of twins diagnosed by Curtius, after careful examination of the fetal membranes, as dichorial. On the basis of their extreme similarity all of these cases would have to be diagnosed as monozygotic. Hence fetal membrane conditions are unreliable criteria for the diagnosis of zygosity in twins. (After Curtius).

but these differences, when interpreted as the effects of more or less pronounced asymmetry reversal, help rather than hinder their diagnosis as monozygotic twins. The rather slavish quantitative and qualitative objective comparison of dermatoglyphic units, and the ranking of pairs on the basis of this comparison, means little unless adjudged in the light of changes due to asymmetry reversal and bimanual differences in the expression of pattern characters. Also the interpretation of resemblances would be inadequate without a knowledge of whether the individual is a right hander or a left hander.

Since this whole matter of the remarkable and consistent differences in the expression of pattern in the two hands and asymmetry reversal of patterns in many identical twinns is dealt with in a recent paper[3] it seems unnecessary to do more than state that unless palmer dermatoglyphics are analyzed in the light of these phenomena, diagnoses based on them are lacking in value.

The Proper Function of Dermatoglyphics in Twin Diagnosis

So far as I am aware, no one has ever claimed to be able to diagnose twins on the basis of dermatoglyphics alone. Just to test the possibilities of this sort of diagnosis, I tried to identify the first 42 pairs of twins in our collection by a study of their palm prints, which were merely numbered serially. Thirty-eight of the 42 were positively identified and were in agreement with diagnoses based on similarities; two were diagnosed correctly but there was some doubt; and two were incorrect. This rather high percentage of agreement speaks well for the



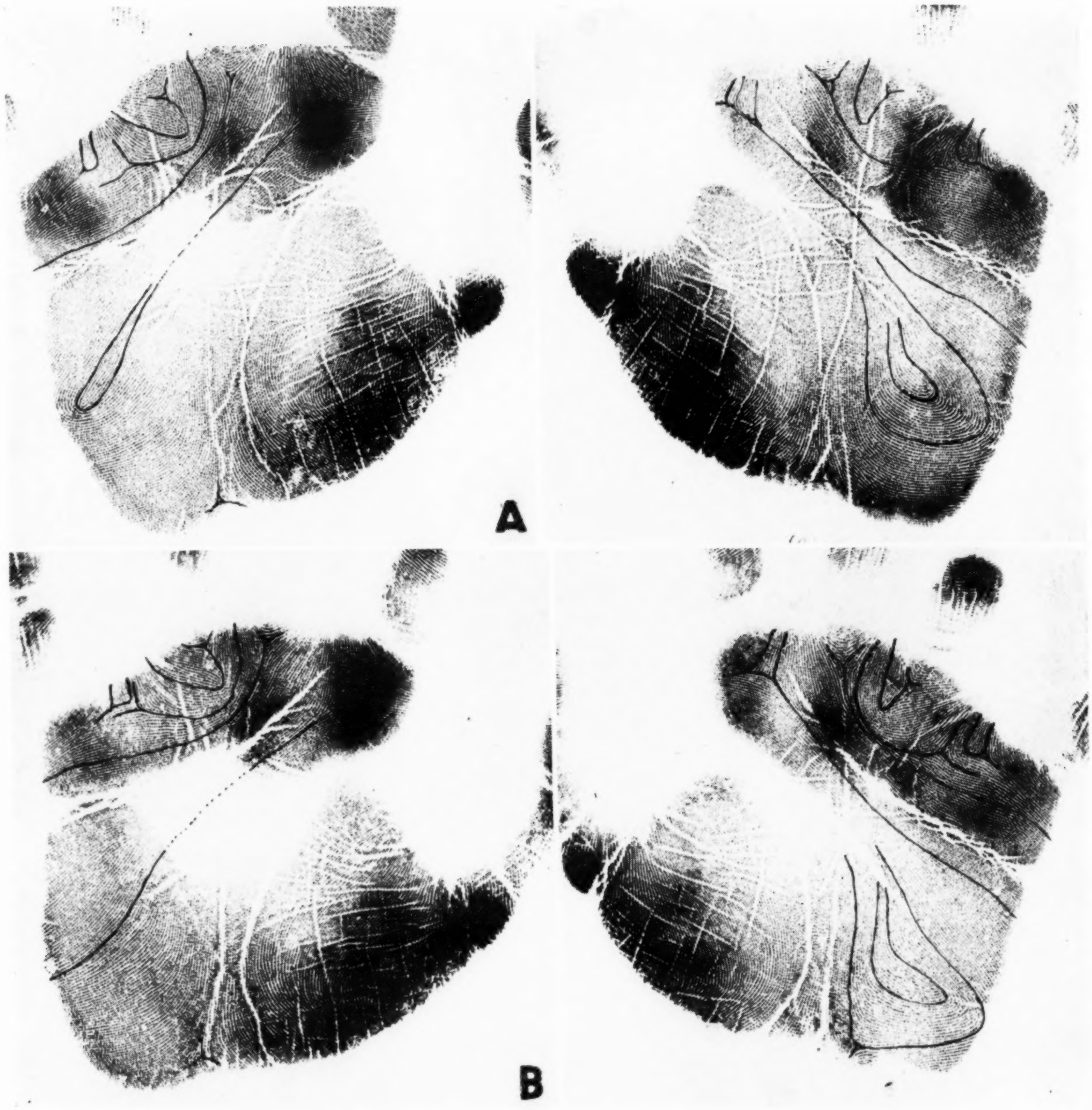
IDENTITY ESTABLISHED BY PALM PRINTS

Figure 2

Palm prints of identical twins No. 49. The two upper palms belong to twin A, the two lower to twin B. The formulae for these palms are as follows:

Twin A	L:	11-11.9.7.11/5'-tt'-L^r/L^u.V.D.W.W.
	R:	11-11.9.7.11/5'-t' -L^r/L^u.V.D.W.W.
Twin B	L:	11-11.9.7. 5' 5' -t' -L^r/A^c.V.D.W.W.
	R:	11-11.9.7. 5"-5"-t'- /A^u. L^uO.D.W.W.

While not the most similar palms so far as correspondences in formulae go, for on this score the two hands of A are more alike than like either of B, there is extraordinary correspondence between A and B in a whole series of rare patterns, especially the whorls in interdigitals II and IV. No other resemblance between individuals so impressive as this occurs in any of the other twins we have studied.



AVERAGE RESEMBLANCE IN PALM PRINTS

Figure 3

Palm prints of identical twins No. 55. This pair of palms represents about the average condition found in identical twins. The formulae for these are as follows:

Twin A..... L: 9-7.7.5″.h-t-L^{r}/A^{u}.O.M.O.L/D.
R: 10-7.9.6.5′-t-L^{u}.O.V.L.D.

Twin B..... L: 9-7.7.5″.4-t-A^{u}.O.M.O.L/D.
R: 9(10)-7.9.5″(6).5′-t-L^{r}.O.V.L.D.

This is a case in which, although the formulae are not impressively similar, resemblances in genetic details require a monozygotic diagnosis.

LEAST ALIKE IN PALM PRINT PATTERN

Figure 4

Palm prints of identical twins No. 41. These palms represent the extreme degree of lack of resemblance found in our collection of fifty pairs of identical twins. The twins themselves were placed second to last in respect to degree of closeness of general bodily resemblance. Their photographs are shown in Figure 6. Although these palms are rather badly printed, it is not difficult to write the formulae:

Twin A.....L: 8.6.5″.5′-t-A^{u}.O.O.O.L.
R: 9(8).7(6).5″.3-t-A^{u}.O.O.O.L.
Twin B.....L: 9.0.5″.5′-t-L^{r}.L/L.O.O.O.
R: 10.0.6.4-?-L^{r}.O.O.O.O.

Here both patterns of twin *B* are more right-handed in their patterns than either hand of twin *A*. *B* is right-handed and *A* left-handed. This is the type of case in which the dermatoglyphics alone would not be satisfactory for a diagnosis of zygosity.

PALM PRINTS OF FRATERNAL TWINS

Figure 5

Palm prints of the most similar pair of twins diagnosed as dizygotic. Here the two palms of A are much more similar to each other than either is to those of B. The formulae are as follows:

Twin A.....L: 10.X.6.3-tt'-A^u/L^u.O.O.O.O.
R: 11.9.7.4-tt'-A^u/L^u.O.O.L.O.
Twin B.....L: 9(10).7.5″(6).2-tt'-L^r/A^c.O.O.O.L.
R: 9.7.5″.2-t″-L^c.O.O.O.L.

On the basis of palm prints alone one could hardly diagnose these as other than dizygotic. This serves to confirm a similar diagnosis based on differences in other genetic characters such as hair and teeth.

UNLIKE BUT IDENTICAL

Figure 6

Photographs of identical twins No. 41, whose palm prints are shown in Figure 4. The differences in expression here shown are habitual in these twins. *A* was always smiling, *B*, always solemn. In a long list of genetic details, however, they were so strikingly similar that we were forced to diagnose them as identical (monozygotic). *B*, who is right-handed, has the larger head, is larger and heavier, and apparently more vital. *A*, who is left-handed, shows pronounced mirror-imaging also in tooth arrangement. Certain dental peculiarities found on the right side of *A* are found on the left side of B. These twins represent that type of identical twins that are least similar and that show most extensive asymmetry reversal in one of the twins.

diagnostic value of dermatoglyphics, but these alone are not infallible and were never claimed to be so.

My method of diagnosing twins about whose embryonic membranes we know nothing, is a modification of Siemens' method. First of all I diagnose all opposite-sexed pairs without further ado as dizygotic. When I first see a same-sexed pair I can tell at a glance in over 90 per cent of cases, whether they are monozygotic or dizygotic. They are either so strikingly similar in countenance, carriage, body build, expression, voice, coloring, etc., that they could hardly be other than monozygotic; or else they are so different in all these respects, or in most of them, that they must be dizygotic. The difficulties are confined to the remaining 8 or 10 per cent. These require much more careful handling. They are subjected to the similarity test and this usually succeeds in separating them rather readily. Still there may remain two or three per cent of cases about which there lingers a slight doubt and for which still further data are needed. Here is where dermatoglyphics affords the crucial test.

In dealing with palm prints as an

aid to diagnosing twin pairs of this slightly doubtful sort, every available item is taken into account. I ask myself the following questions in about this order:

1. Are the hands of the two twins of the same general shape and size?
2. Are the fingers of the same relative length and breadth?
3. Is the general texture of the friction ridges about the same? Are they both coarse, both fine, both medium, or have they both the same general peculiarities of texture?
4. Are any unusual peculiarities of pattern present in the two in which they are more closely similar than would be expected in two individuals genetically unlike?
5. Are there evidences of asymmetry reversal, or mirror-imaging, in the main-lines or patterns of one of the twins?
6. Is one hand of one twin on the whole more like one hand of the other twin than like his own other hand?
7. Finger prints must also be subjected to the same scrutiny and the same questions asked about them as are asked about palm prints. Quite commonly, when the palm prints are difficult to analyze, finger prints tell a plain story.[4] Especially is this true when two corresponding finger prints in two individuals show resemblances of an unusual sort such as those shown in the Frontispiece. Such resemblances are frequent in monozygotic and never occur in dizygotic twins.

If I can answer all of these questions affirmatively about a pair of twins that in other respects has been diagnosed a little doubtfully as monozygotic, I more confidently place this pair in the "identical" category. If I must answer most of these questions in the negative about a pair of twins that were already almost certainly diagnosed as dizygotic, this diagnosis is considered as confirmed.

Thus it is seen that, instead of attempting to use dermatoglyphics as a sole criterion for diagnosing twins, I use them only as a final check on diagnoses already nearly complete. This, I believe, is a legitimate use of this material, but even such use might lead to wrong diagnoses if handled by one who has not taken into consideration the bimanual asymmetry in palm patterns and the tendency of this bimanual asymmetry to undergo complete or partial reversal in monozygotic twins. It should be especially emphasized that partial reversals tend to obliterate both homolateral and heterolateral resemblance, and hence to make rigid objective comparisons most difficult and often meaningless.

Literature Cited

1. Cummins, H. 1930. Dermatoglyphics in twins of known chorionic history, with reference to diagnosis of the twin varieties. *Anat. Rec.*, V. 46.

2. Curtius, Fr. 1930. Nachgeburtsbefunde bei Zwilligen und Ahnlichkeite-diag*nosis... Arch. f. Gynäkologie*, Bd. 140, Heft 2 u. 3.

3. Newman, H. H. 1930. The palmer dermatoglyphics of twins. *Amer. Jour. Phys. Anthrop.*, V. 14, No. 3.

4. Newman, H. H. 1931. The finger prints of twins. *Jour. of Genetics*, V. XXII, No. 3.

The Human Constitution

DIE BIOLOGIE DER PERSON, edited by T. Brugsch and F. H. Lewy. Parts 15-17. Price 13.—, 12.—, and 35.— marks respectively. Single parts not for sale. Publishers: Urban & Schwarzenberg, Berlin and Vienna, 1929-1931.

IN earlier volumes of this Journal (vol. 18, p. 503; vol. 20, p. 480), reviews have been published concerning a comprehensive book dealing with the human constitution, edited by T. Brugsch and F. H. Lewy. The three final issues of this work have now appeared. Part 15 contains chapters on the ear by H. Haike and on the skin by F. Pinkus. Haike gives a very interesting description of the anatomy

and morphology of the ear with particular reference to variations in the shape of the ear. He also gives detailed accounts of the general and constitutional characteristics of otosclerosis, hereditary impairment of hearing through defects of the inner ear, and deaf mutism, and discusses the inheritance of these traits. The report by Pinkus concerning the skin and its relations to the human constitution covers the following subjects: the wrinkles of the skin with particular reference to their relation to age, mimics and skin, physical and chemical properties of the skin and their relation to age, skin pigmentation (normal and pathological, albinism), the characters of hair and nails, excretions of the skin, the reactions of the skin to physical injuries, the relations between endocrine secretion and skin characters, inheritance of normal and pathological traits of the skin, effects of poisons upon the skin, and so on. These two chapters dealing with ear and skin undoubtedly belong among the best in the whole work. Part 16 contains a report by F. Munk dealing with physiological and pathological conditions and functions of the kidneys and their relation to the human constitution. There is a chapter concerning congenital malformations of the kidneys. K. Dresel and F. Himmelweit describe the constitutional relationships of the vegetative nervous system. The final issue opens with a rather long contribution by E. Flatow-Worms concerning handwriting and character. The author describes in detail the variations in the different characters of handwriting and interprets their relationship to character traits. Unfortunately, however, she leaves it entirely to the reader to believe in the correctness of her assumptions as no proofs of any kind are offered. The concluding chapters, written by a series of authors, report upon the experimental evidence for the existence of different psycho-physical human types.

These final issues of the "Handbuch" by Brugsch and Lewy reaffirm the earlier impression that the editors have performed a valuable task in assembling the available information concerning the human constitution and its expressions. In the choice of some of the contributors, the editors obviously were not very fortunate; on the whole, however, the work represents an extremely valuable source of information concerning heritable and non-heritable human traits. In many fields it should stimulate new research.

WALTER LANDAUER.

Diseases of Plants

FUNGUS DISEASES OF PLANTS, *by* JACOB ERIKSSON. Translated from the German by Wm. Goodwin. Pp. vii and 526. 399 Illus. 22 Chapters. Charles C. Thomas, Springfield, Ill. 1930.

THIS book contains only incidental and occasional reference to the manner of inheritance of resistance and susceptibility to diseases considered. The fact of differential resistance among plant forms is frequently stated, usually without much detail on experimental results. Although the book would be a valuable addition to one's library as an excellently illustrated source of information on diseases of plants, it can not be considered as an adequate reference work on inheritance of disease resistance and susceptibility.

C. E. LEIGHTY.

INHERITANCE OF SMUT RESISTANCE AND JUICINESS OF STALK

In the Sorghum Cross, Red Amber × Feterita*

ARTHUR F. SWANSON and JOHN H. PARKER†

SORGHUMS are subject to several diseases, of which the covered kernel smut *Sphacelotheca sorghi* (Link) Clinton (Figure 7) is the most destructive. The annual loss from sorghum smut in the United States is estimated by Reed and Melchers[5] at three million dollars, most of which is caused by the covered kernel smut. Kernel smut is widely distributed in the sorghum-growing regions of the world. The chief damage is due to the destruction of the grain. It is not uncommon to find from 30 to 50 per cent of the plants infected in commercial fields. Ordinarily, however, the percentage is much smaller and some fields may be entirely free of smut. Kernel smut may be nearly absent on a farm in one season, only to appear in a destructive outbreak the following year.

Sorghums with juicy stalks are better suited for forage or silage than varieties with dry, pithy stalks. All sorgos are juicy and sweet. Either dryness or juiciness of stalk can be combined with smut resistance and desirable grain qualities through plant-breeding methods; hence, a knowledge of the inheritance of these characters is of value.

Inheritance of Resistance to Covered Kernel Smut

Varieties of sorghum differ in their resistance or susceptibility to kernel smut, as has been shown by Reed and Melchers[5] and Tisdale, Melchers and Clemmer.[6] There are at least three known physiologic forms of covered kernel smut, but the most prevalent is form 1‡ which attacks kafirs and is commonly present in the southern Great Plains. Forms 2 and 3 attack milo and certain strains of feterita, respectively. It is known that Red Amber sorgo is susceptible to form 1 while feterita is immune to it. To determine the inheritance of resistance or susceptibility in relation to the dry or juicy character of the stalks of the plants, the seeds from 284 F_2 heads from the cross Red Amber × feterita were inoculated with spores of form 1§ in 1920 at Hays, Kans. Each individual row as grown in the F_3 generation was planted with seed from the F_2 generation selected at random. The segregation for smut infection in relation to character of stalk is shown in Table I.

By placing the rows containing some smutted plants in one group and those with no smutted plants in another group, a close approximation to a 3:1 ratio is obtained, *i. e.*, susceptibility to smut appeared dominant to resistance, as shown by Reed.[4]

Inheritance of Juiciness of Stalk

In 1916, Hilson[1] observed in India

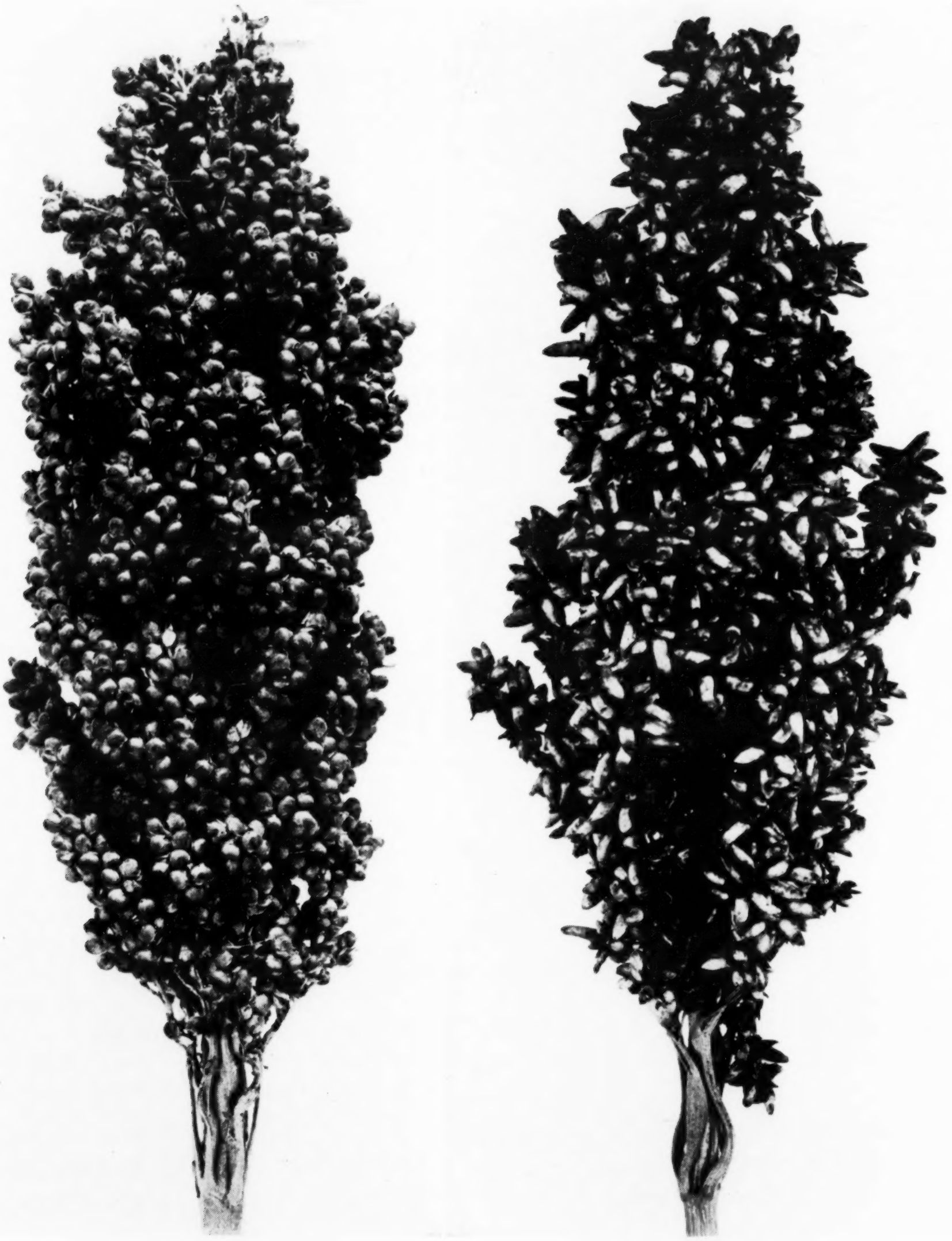
---

*Joint contribution from the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Dept. of Agriculture, and the Kansas Agricultural Experiment Station, Manhattan, Kans. (Contribution No. 192, department of agronomy, Kansas State Agricultural College.)

†Associate Agronomist, Office of Cereal Crops and Diseases; and Agronomist, Office of Cereal Crops and Diseases, and Professor of Crop Improvement, Kansas Agricultural Experiment Station, respectively.

‡Designated as physiologic form 1 by Melchers, Ficke and Johnston.[2]

§The inoculum was supplied by Prof. L. E. Melchers, department of botany and plant pathology, Kansas Agricultural Experiment Station.

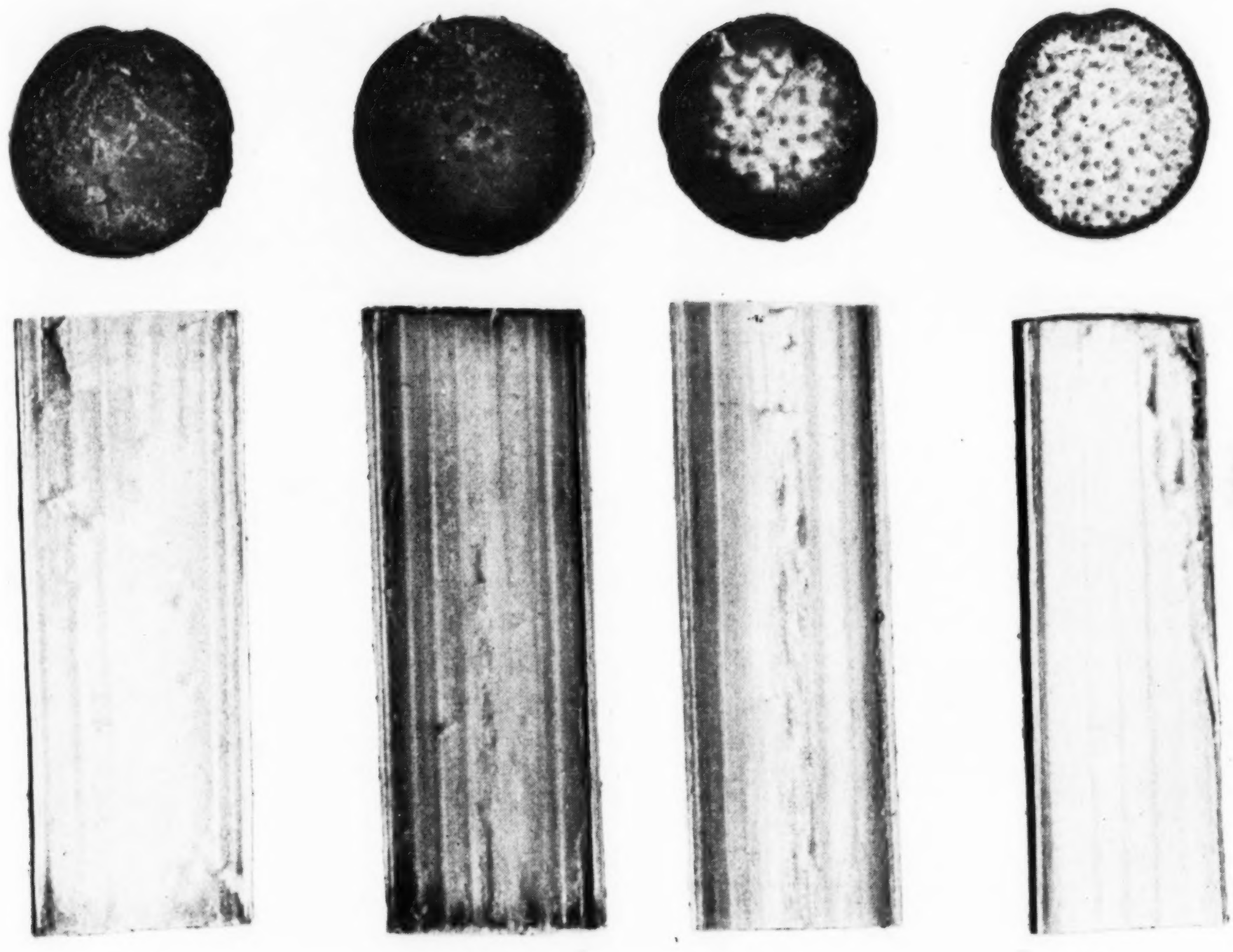


A B

SPHACELOTHECA SORGHI ON SUMAC SORGO

Figure 7

A, Sound head; *B*, infected head in which the kernels are replaced by masses of smut spores. This fungus damages the sorghum crop of the United States to the extent of nearly three million dollars a year.



A B C D

DRY AND JUICY STALKS

Figure 8

Cross and longitudinal sections of juicy and dry stalks. *A*, Red Amber sorgo (juicy); *B*, juicy hybrid; *C*, dry hybrid; *D*, feterita (dry).

that sorghum plants having leaves with clear white midveins had dry, pithy stalks. Plants having leaves with dull or cloudy midveins were found to be juicy. The dull appearance is due to the presence of juice. Hilson found that the dry stalk is dominant to the juicy stalk and that the inheritance of this pair of characters is controlled by a single-factor difference.

The inheritance of the stalk character in the F_2 generation of the cross Red Amber $\times$ feterita was studied at Hays, Kans., in 1919.

The dry and juicy characters are illustrated in Figures 8 and 9. The data on inheritance of the character of stalk in F_2 are given in Table II.

The data on segregation of stalk character in this F_2 generation are satisfactorily explained on the basis of a single factor difference. The fact that the character of the stalk may be judged by the appearance of the midvein of the upper leaf blade is of considerable importance to the sorghum breeder. Most forage sorghums have sweet, juicy stalks. Nearly all of the sorgos have seeds which are bitter and unpalatable and therefore undesirable either for market grain or for feeding purposes. Through plant breeding methods, it is possible to transfer the juiciness of the sorgos to grain-sorghum types and thus create new varieties of value for both forage and grain. Atlas sorgo, a new variety recently distributed to the farmers of Kansas by the Kansas Agricultural Experiment Station, is a good example of a

A B C D

JUICINESS AND MIDVEIN COLOR

Figure 9

Leaves with dull grey and with white midveins. *A*, Red Amber sorgo (juicy); *B*, F_2 hybrid (juicy); *C*, F_2 hybrid (dry); *D*, feterita (dry).

hybrid type which combines palatable grain with the juicy, sweet stalks, leafiness, and forage-yielding capacity of the sweet sorghums.[3]

If the factor *K* is postulated as being responsible for susceptibility to the ordinary form 1 of kernel smut, and the factor *D* for dry stalks, and their recessive allelomorphs are designated as *k* and *d*, the segregation of smut susceptibility and character of stalk in the Red Amber × feterita cross, as grown at Hays, may be shown as indicated in Table III.

Although these data do not afford statistical proof of linkage between smut reaction and character of stalk, smut counts on the F_3 rows showed that the percentages of smutted plants were higher in the rows homozygous for juicy stalks than in the rows with pithy-stalked plants. Considering only the F_3 rows with some smutted plants, the average percentage of smut in the juicy rows was 6.3 and in the pithy rows, 1.2.

In the F_3 to F_8 generations of this cross grown from 1920 to 1925 the average percentage of juicy-stalked rows with some smutted plants was 42.2, while the average percentage of rows with pithy-stalked plants containing some smutted plants was only 16.9.

Observations of varieties and experimental breeding results show that there are distinct genetic factors for sweetness and juiciness of stalks. Kafirs are juicy but not sweet. Sorgos are juicy and sweet. The mode of inheritance of sweetness was not determined in this cross. The association which the observations suggest may exist between smut susceptibility and juicy stalks, may be a case of physiological correlation between smut susceptibility and sweetness rather than linkage between genetic factors for smut susceptibility and juicy stalks.

The prevalence of form 1 kernel smut is not confined to strains with juicy stalks. Such extremely dry-stalked varieties as White durra and shallu are highly susceptible, while feterita, another extremely dry-stalked variety, showed almost complete immunity. The milos which are only slightly juicy, and Dwarf hegari, which is distinctly juicy, are almost completely immune to form 1.

Summary

The mode of inheritance of reaction to covered kernel smut (*Sphacelotheca sorghi*) in the cross, Red Amber X feterita, was determined by testing F_3 head rows from a random sample of F_2 plants. The results can be explained satisfactorily on the basis of a

Table I. Inheritance of reaction to smut in relation to character of stalk in the F_3 generation of the cross Red Amber x feterita, grown at Hays, Kans., 1920.

Number of F_3 head rows	Character of stalk	F_3 head rows— Containing some smutted plants: Number	Per cent	Containing no smutted plants: Number	Per cent
84	Dry	60	71.4	24	28.6
142	Segregating	104	73.2	38	26.8
58	Juicy	47	81.0	11	19.0
	Observed	211	75.2	73	24.8
	Calculated (3:1)	213	75.0	71	25.0
	Deviation	2 ± 4.9			

Table II. Segregation of F_2 plants for character of stalk in the cross Red Amber x feterita, grown at Hays, Kans., 1919.

	Number of plants with dry stalks	Number of plants with juicy stalks	Total number of plants
Observed	103	34	137
Calculated (3:1 ratio)	102.75	34.25	137
Deviation		.25 ± 3.42	

Table III. Inheritance of reaction to kernel smut in relation to character of stalk (dry or juicy) in F_3 progeny rows planted from a random sample of F_2 heads of the cross Red Amber x feterita, grown at Hays, Kans., 1920.

	Homozygous dry and segregating (dry and juicy) rows: With some smut	With no smut	Homozygous juicy rows: With some smut	With no smut	Total
Observed	164	62	47	11	284
Calculated (9:3:3:1)	159.75	53.25	53.25	17.75	284
Deviation	4.25	8.75	-6.25	-6.75	
Factorial constitution	1 KKDD 2 KKDd 2 KkDD 4 KkDd	1 kkDD 2 kkDd	1 KKdd 2 Kkdd	1 kkdd	
Ratio*	9	3	3	1	

* $X^2 = 4.4849$. $P = 0.2161$

With a P value of 0.2161, the deviation from the calculated results is such as might be expected approximately 22 times out of 100 on the basis of random sampling alone.

single-factor difference. Susceptibility appears to be dominant to resistance.

Dry stalks are dominant to juicy stalks, and the inheritance of this pair of characters is controlled by a single-factor difference.

No conclusive evidence of genetic linkage between the factors for reaction to smut and those for dry or juicy character of the stalk was obtained in studies of the F_3 population grown at Hays in 1920. In subsequent generations of the same cross there was a tendency for the hybrid selections having juicy stalks to be slightly more susceptible to kernel smut than the lines with dry, pithy stalks.

Literature Cited

1. Hilson, G. R. 1916. A note on the inheritance of certain stem characters in sorghum. *Agr. Jour. India,* 11:150-155.

2. Melchers, L. E., C. H. Ficke and C. O. Johnston... 1930. Physiologic specialization in *Sphacelotheca sorghi* (Abs.) *Phytopathology* 29(1):142-143.

3. Parker, J. H. 1929. Sorgo known as Atlas yields well and resists lodging. *U. S. D. A. Yearbook,* 1928:551-553.

4. Reed, George M. 1928. The inheritance of resistance in sorghums to covered kernel smut. *Brooklyn Bot. Gard. Rec.* (17th Ann. Rpt. 1927) 17:47-48.

5. Reed, George M., and Melchers, Leo E. 1925. Sorghum smuts and varietal resistance in sorghums. *U. S. D. A. Bul.* 1284, 56 p., 2 figs.

6. Tisdale, W. H., Melchers, L. E., and Clemar, H. J. 1927. Strains of kernel smuts of sorghum, *Sphacelotheca sorghi* and *S. Cruenta. Jour. Agr. Res.* 34:825-838.

Books Received

BOOKS are acknowledged in this column as received, and such acknoweldgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the Journal *will be reviewed in later numbers.*

INTERNATIONAL DIRECTORY OF PEDIGREE STOCK BREEDERS, An Index of Pedigree Stock Breeders in Great Britain, the Overseas British Dominions, and all Civilized Countries. A Handbook Recording Breeds and Stock Breeding, etc., in Every Country of the World. Compiled and Edited by R. de Toll. Pp. 1070. 138 Illustrations. The Vernon Press, Ltd., London. 1930.

Many excellent illustrations of livestock breeds from all parts of the world, both in the text and in the advertisements. The list of breeders and breed associations is probably the most extensive international list of animal breeders in existence.

MANUAL ON RESEARCH AND REPORTS, With Special Application to Investigations in the Field of Business, Economics, and Public Affairs. Issued by the Committee on Research of The Amos Tuck School of Administration and Finance, Dartmouth College. Pp. 108. 7 Chapters. Price $1.25. Williams & Wilkins Company, Baltimore. 1931.

Compiled primarily for the benefit of the compiler of business or economic "research" reports, some parts of it (Tables, style, etc.—"a table need not be dull or forbidding in appearance") are not without their application to those reporting research in biology.

THE MONEY ILLUSION, *by* Irving Fisher, Professor of Economics, Yale University. Pp. 245. 8 Chapters and a Supplement. Price, $2.00. Adelphi Company, New York. 1928.

Even when prodded with X-rays a gene mutation is rather a rare event. Not so with the values of the dollar, the pound, and the mark, which change over night—and almost every day. Fisher believes that the "havoc-working drunken dollar" has much to do with our economic welfare. Whether "stabilization" is racially desirable in an essentially dysgenic civilization is a

question. Perhaps depressions are all that is left of the stringency of man's original environment, and prosperity endlessly prolonged would only mean more rapid deterioration.

DRIFTING SANDS OF PARTY POLITICS. *By* OSCAR W. UNDERWOOD, Late U. S. Senator from Alabama. Pp. 422. 32 Chapters. Price, $3.50. The Century Company, New York. 1928, 1931.

The "rock" of prejudice, greed, misinformation, special privilege, and a number of other equally unpromising ingredients, on which is founded government of the people—by the people—for the people. On this foundation rests the future of our race!

GENETIC STUDIES OF GENIUS, Volume III, THE PROMISE OF YOUTH, Follow-up Studies of a Thousand Gifted Children. By BARBARA STODDARD BURKS, DORTHA WILLIAMS JENSEN, LEWIS M. TERMAN. Pp. 508. 4 Parts, 28 Chapters. Price, $6.00. Stanford University Press, Stanford University, California. 1930.

Popular prejudice has pictured the child prodigy as germinating into a virtual moron ere he reaches years of discretion. This progress report on the development of the thousand children of exceptional I. Q. studied in earlier volumes of the series does not lend much comfort to this view. Further comment would prejudice a review *in extenso* later, but a discouraging thought persists: Almost all bright children would be acutely aware that they were subjects of a "genetic study of genius." Can the effect on the ego of this knowledge be overbalanced by their superior I. Q.'s? One wonders.

THE MYSTERIOUS UNIVERSE, *By* SIR JAMES JEANS. Pp. 163. 5 Chapters. 2 Plates. Price, $2.25. The Macmillan Company, New York. 1930.

A study of our environment to the *Nth*. In space so vast that every teaspoonful of matter catalogued by the astronomer has forty trillion cubic miles of empty nothingness to play around in, the actual existence of a green, fertile world, with chromosomes and cabbages and party politics is miracle enough!

PURITAN'S PROGRESS, *By* ARTHUR TRAIN. Pp. 477. 19 Chapters. Price, $3.50. Charles Scribner's Sons, New York. 1931.

From the days of Jonathan Edwards and Elizabeth Tuttle (blessed eugenically) to the polyglot Boston of 1931 is a long stride (or slide?) in the history of the race, and Faneuil Hall still serves as a public market and still echoes the verbosely drifting sands of party politics! From the squeamishness of 1839 that draped Boston statuary (and still drapes Boston literature, if reports be true) to the frankness of 1931 is also a long leap—and a hopeful one.

THE REGULATION OF SIZE AS ILLUSTRATED IN UNICELLULAR ORGANISMS, *By* EDWARD F. ADOLPH, Associate Professor Physiology in the University of Rochester. Pp. 233. 12 Chapters. 66 Figures, 15 Tables. Price, $4.50. Charles C. Thomas, Springfield, Ill. 1931.

Cells vary enormously in size. Single cells of Valonia as large as a hen's egg are successfully functioning organisms; at the other end of the scale, the reproductive facility of many microscopic and ultramicroscopic bacteria rivals the [advertised] lethal facility of Listerine. The factors controlling size of cells are many and complicated, and are by no means eluciadated by this book, even though much interesting material is presented.

THE SCIENCE OF BIOLOGY, An Introductory Study. Revised and Reset. By George G. Scott Ph.D., Professor of Biology in the College of the City of New York. Pp. 633. 3 Parts, 27 Chapters. 390 Figures. Price, $3.75. Thomas Y. Crowell Co., New York. 1930.

Rather well illustrated shotgun text. Biometricians may ponder whether the following is a swat or a boost: "The methods [biometrical] are especially applicable to the study of quantitative inheritance which apparently does not lend itself, on account of complexity, to analysis by Mendelian methods to be explained presently. It does not follow, however, that on this account the information gained is necessarily valuable." Dr. Scott does not present a formula that will *assure* the gaining of valuable

information, so perhaps there is hope for biometrics!

DISEASES TRANSMITTED FROM ANIMALS TO MAN, *By* THOMAS G. HULL, Chief Bacteriologist, Illinois Department of Public Health. Pp. xxiv and 352. 27 Chapters. 29 Illustrations, 43 Tables. Price, $5.50. Charles C. Thomas, Springfield, Illinois. 1930.

From animals to man: T. B., anthrax, foot and mouth disease, Malta fever, milk sickness, actinomycosis, small [cow] pox, glanders, rabies, psittacosis [but not city-cosis], food poisoning, erysipelas, plague, tularemia, spirochetal jaundice, rat-bite fever, Rocky Mountain fever, not to mention parasites. From man to animals: septic sore throat, diphtheria, scarlet fever, tuberculosis. Truly a remarkable list, and the fundamentalists recognize no relationship!

Urban and Rural Birthrates

THAT birth control or decreased fecundity, or both, is responsible for nearly twice as many childless families in cities as compared with country districts is indicated by an analysis of hitherto untabulated and unpublished data from the federal census made public by the Milbank Memorial Fund.

This striking difference in the number of no-child marriages in the urban and rural populations was revealed in a study of the original enumeration schedules for 69,620 married women of native-white parentage, taken from the 1910 census. The study was made by the Fund's division of research.

Among women 40 to 49 years of age, 16 per cent of those living in cities were childless, as compared with 9 per cent of those living in the country. The urban samples were selected from the 33 northern cities of 100,000 to 500,000 population, and the rural samples, from 74 counties neighboring the cities.

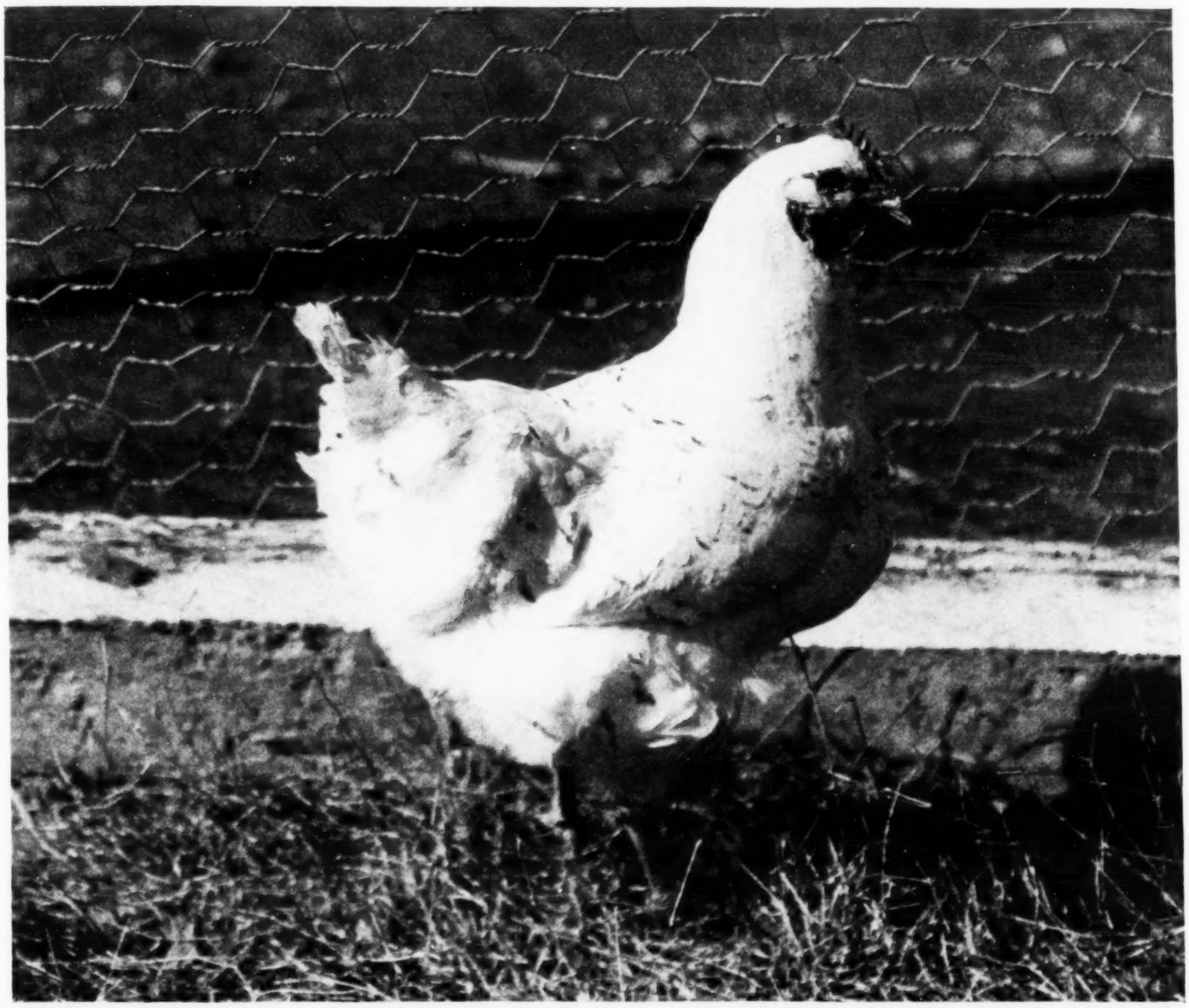
Childless marriages were found to be two and one-half times as common among professional people in the cities as among farm laborers. In the city groups, 18 per cent of the wives of professional men were childless, as were 16 per cent of the wives of business men, 15 per cent of the wives of skilled workers, and 14 per cent of the wives of unskilled workers. Among the rural groups, 10 per cent of the wives of farm owners and 7 per cent of the wives of farm renters and of farm laborers, were without offspring.

Whether this greater frequency of no-child families among urban married couples, and especialy among the "upper" classes, represents choice or sterility or both, is not apparent from the data analyzed. However, it is suggested by collateral evidence that, because of the greater expense of having children in cities and in view of the higher standards of living of the professional classes, birth control is practised to a greater extent among the so-called "upper" classes.

This analysis of childless marriages is one of a series of related studies of population problems upon which the Milbank Memorial Fund is engaged. The directors and advisers of the Fund believe that scientific knowledge concerning certain phases of population problems will be a valuable aid in directing present and future programs in public health and social welfare.—*Information Service, Milbank Memorial Fund.*

A HEN WITH VARIABLE PLUMAGE COLOR

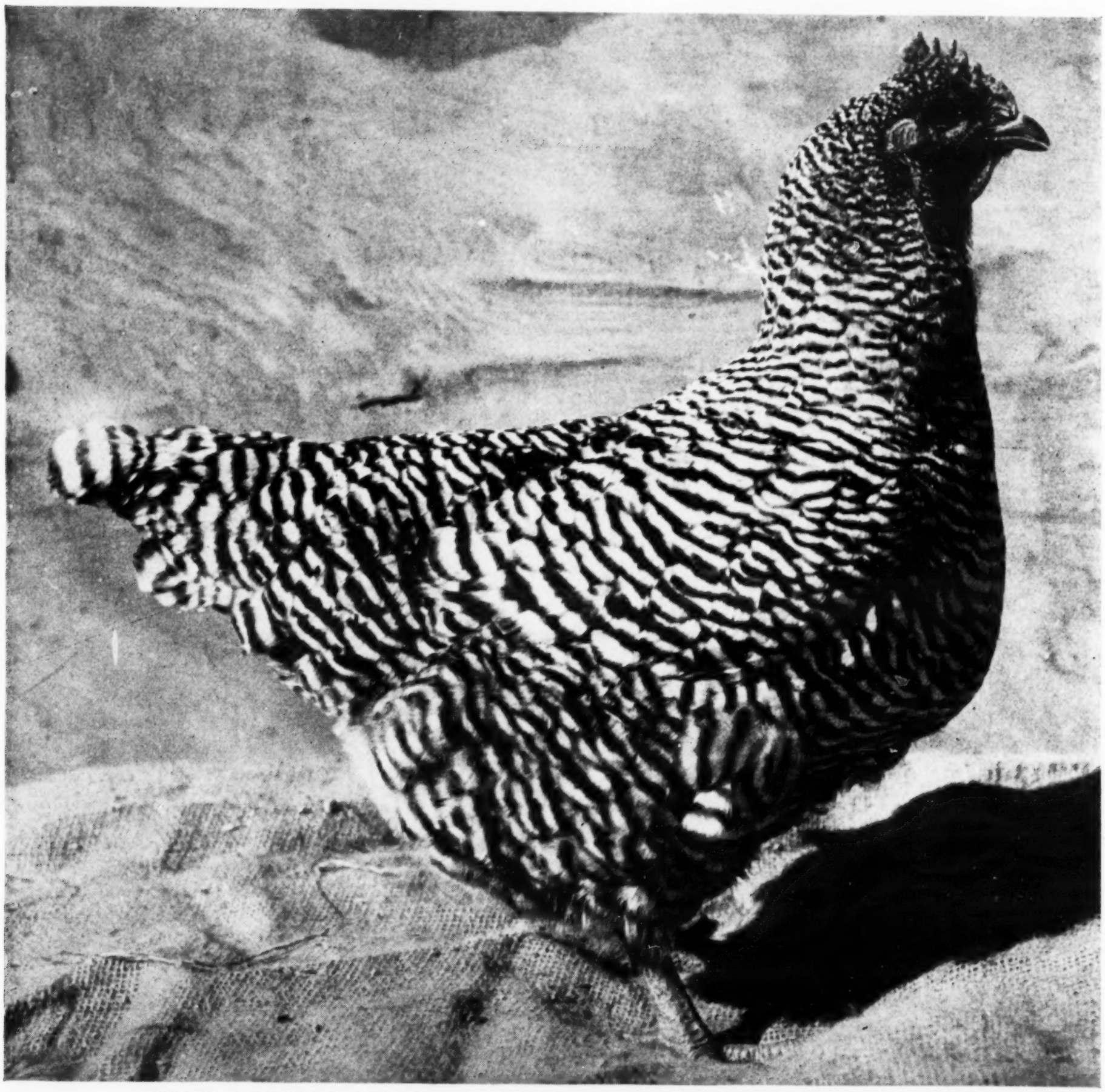
C. B. GODBEY, *Associate Professor of Genetics*
D. H. REID, *Professor of Poultry Husbandry*
Agricultural and Mechanical College of Texas



A "BLONDE" BARRED ROCK
Figure 10

This picture shows the appearance of hen 431 in December, 1927, after completing her first moult. She had had normal barred Rock plumage before the fall moult. The next moult brought about no change. Figure 11 shows the appearance of this hen in the Fall of 1930.

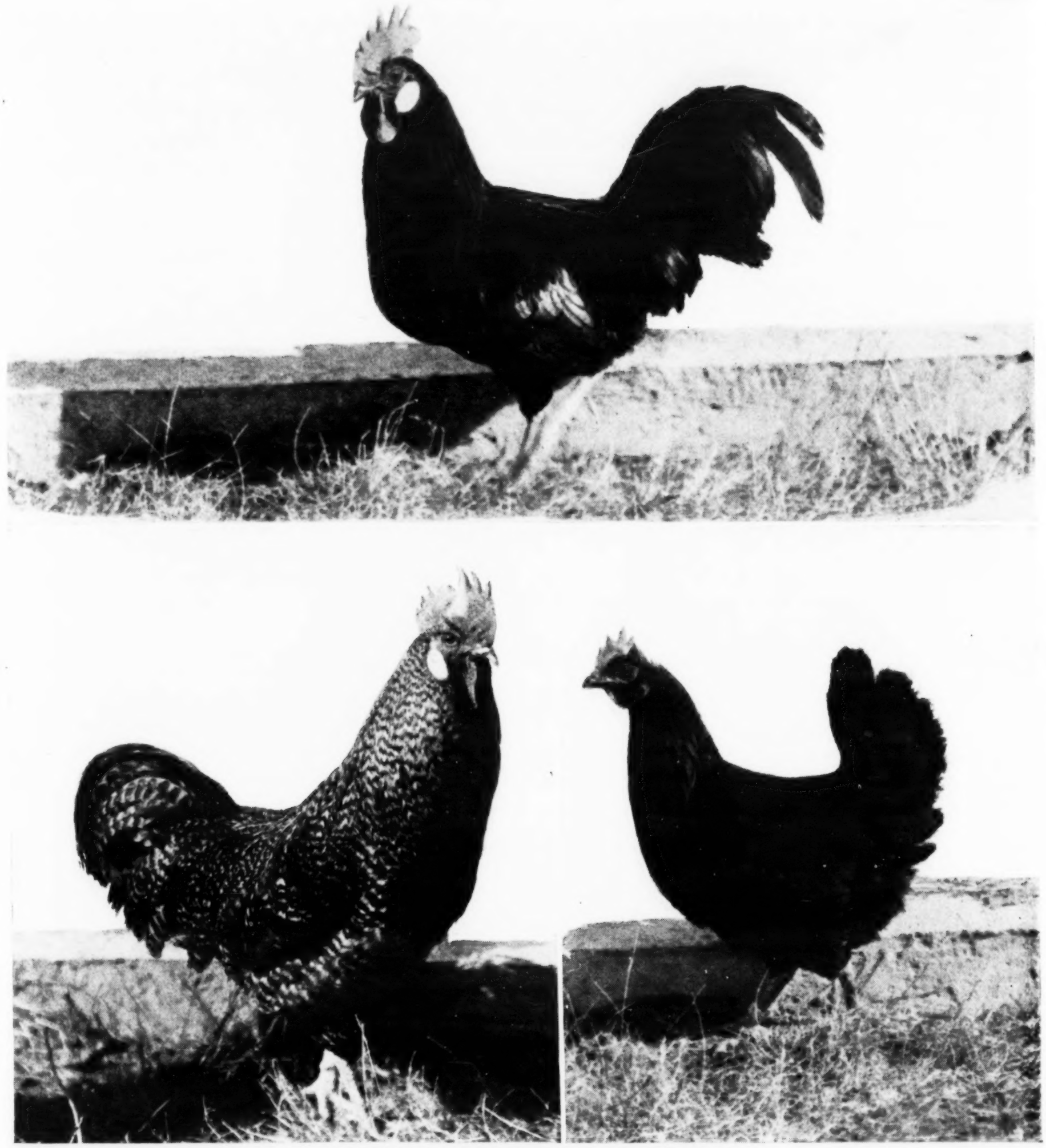
COLOR changes in the plumage of the domestic fowl are probably more common than one would infer from the number of such cases reported in the literature. Lippincott[2] reported a case of a Blue Andalusian hen which changed color. This hen in the spring of 1917 had the appearance of a normal Blue Andalusian. After the fall moult white hackle and primary wing feathers appeared. After completion of the moult the following year she was snowy white in appearance, in which condition she was at the time the report was made. After the completed change, as well as during the time the change was being made, she bred



THE APPEARANCE OF HEN 481 ON DECEMBER 11, 1930
Figure 11

She has completed her fall moult and has become again a normal-appearing Barred Plymouth Rock. Her genetic constitution, as determined by breeding tests, and the appearance of her plumage, again are in agreement.

as a Blue Andalusian. The following report is given by Lippincott in his 1920 paper: "The account of Finches' (1908) hen indicates that the color change was first due to loss of pigment from the feathers after growth and not to a failure of the pigment-manufacturing mechanism to function. The color change came after, and not as the accompaniment of, a moult. During a subsequent moult pigmented feathers were grown which later turned white. Whether the pigment forming mechanism was somewhat interfered with during this moult, or the bird passed through a partial moult only, is not clear." Crew[1] published observations made on a Black Leghorn hen which turned almost white in less than twenty-one months. This hen made the change in a very similar manner to the Blue Andalusian recorded by Lippincott.



GENETIC PROOF OF BARRING

Figure 12

Above is shown the minorca male, No. 212, to which hen 481 was mated during the 1928 breeding season. Below are shown two of the progeny. All the female offspring were black like their father, and all the males were barred. One of each is shown above. This is to be expected, because the dominant factor for barring carried by hen 481 is sex-linked and therefore is transmitted only to her sons.

A Variable-Colored Barred Rock

In December of 1927, a hen with the following life history was presented to the Agricultural and Mechanical College of Texas. She was purchased in the spring of 1927 from a reputable breeder of good quality Barred Plymouth Rocks. At the time of hatching she had the characteristic color markings of a baby

chick belonging to this breed. Her first year's adult plumage was also typical of the breed. By November she had moulted and replaced the barred feathers by white or almost white feathers as shown in Figure 10. In this condition she was first observed by the writers.

Assuming the history of this bird (which was given the number 481) to be correct is equivalent to assuming her genotype to be that of a Barred Plymouth Rock female. Spillmann[3] has shown that barring in this breed is due to a dominant sex-linked gene and that the female is the heterogametic sex. To test the genotype of this white hen, she was mated in the spring of 1929 to a black male (Figure 12). From this mating eleven chicks were produced, five of these were solid black in down color and six were typical Barred Rocks in down pattern. All the chicks with the Barred Rock pattern proved to males while those which were black in down color proved to be females (Figure 12). These results show that hen 481 carried the dominant sex-linked gene for barring, since from a normally barred female mated to a black male the expected results would be equality of barred males and black females.

No change having occured as regards amount of pigment in the plumage, 481 was mated in 1929 to a White Rock male. The white of the White Rock being recessive, this mating was made to test the genotype of the autosomal genes for black color. From this mating all the chicks were black in down color, which indicates that the color genes were carried by the female in the homozygous condition. Later in the season, hen 481 was mated to a Barred Plymouth Rock male. This mating produced only barred chicks. From these breeding tests it is shown that this hen has not only the genotype necessary for the production of barred feathers, but that there is nothing in the genotype to inhibit such a phenotype. After the completion of these breeding tests, it was concluded that 481 is genetically a Barred Plymouth Rock though practically white in appearance. This is no longer a matter of speculation since, after completing the moult this fall (1930) she is as shown in Figure 11, a normal barred hen.

This change back to normal plumage differentiates this case from any other which has been encountered or found recorded in the literature, so this opportunity is taken to place the observation on record.

Literature Cited

1. Crew, F. A. E. 1922. A Black Leghorn which Turned White. *Journal of Heredity*, Vol. XIII, No. 7.
2. Lippincott, W. A. 1920. A Hen which Changed Color. *Journal of Heredity*, Vol. XI, No. 8.
3. Spillmann, W. J. 1906. Barring in Plymouth Rock. Poultry 5.
4. Weismann, A. 1893. The Germplasm. Eng. trans. by W. N. Parker and Harriet Ronnfeldt, New York.

Eugenic Sterilization Summarized

A summary of the present status of eugenic sterilization, with a digest of the principal findings in the study of California's eugenic sterilization law, has been prepared by the Human Betterment Foundation, 312 Pacific Southwest Bldg., Pasadena, Calif. This 12-page pamphlet is available to teachers who wish to obtain copies to distribute to their classes. With sterilization now the law in a majority of the American states, it has become a subject on which every intelligent citizen ought to form an opinion, and for this purpose a condensed statement such as appears in this pamphlet will be particularly useful. Those interested can get supplies of this pamphlet either direct from the Human Betterment Foundation, or through the office of the American Genetic Association.

HEREDITY AGAIN RECOGNIZED BY LAW

Court Decision Upholds Nebraska Statute

THE Supreme Court of the State of Nebraska has recently decided that the state law for sterilizing feeble-minded persons before parole from the state institution is perfectly valid.

The decision involved Frank Clayton, a feeble-minded person who refused to submit to vasectomy. His counsel argued that the law was violating his constitutional right of liberty and that it submitted him to "cruel and unusual punishment."

The opinion of the court is well worth quoting as it gives a very clear and interesting summary of the social and legal factors involved in sterilizing mentally deficient individuals:

From a report of the board of examiners, it appears that Clayton was born in April, 1909; that he has two brothers and two sisters, and that one sister and a brother are likewise of the same institution for feeble-minded at Beatrice. The report also discloses that, while Clayton appears to be physically normal, his mentality is such that he is not capable of progressing beyond the third grade in school, and that his "intelligence quotient," at the time of the hearing before the board was only 40 per cent, as compared to the average 90 or 110 per cent of a normal person. It also appears that while Clayton has been employed at various occupations, while confined at the institution, his mentality is that of a child of six or seven years and that he is rated as a high-grade imbecile.

The evidence of the examining physicians is that Clayton's feeble-minded condition is congenital and not acquired and that his offspring, if any there should be, would inherit about the same degree of mentality that is discovered in him. And from their evidence it appears that Clayton has himself reached his greatest capacity of mentality and that, since his is an established case of hereditary feeble-mindedness, his condition would be transmitted in the germ plasm of his body to his offspring. In the opinion of the examining physicians, who compose the personnel of the board, the sterilization of Clayton is unquestionably advisable.

Constitutional Right Not Violated by Treatment

The operation of vasectomy in a male consists of rendering the individual incapable of begetting offspring. But such an operation does not affect the health of the person upon whom the operation is performed nor does it destroy sexual desire. One physician testified that he had performed more than 50 such operations on both men and women and that no change in the health of the individual was noticeable therefrom. And this witness also points out that the operation comes within the class of minor operations and that it can be performed in 10 or 15 minutes by an efficient surgeon. He also points out that the operation does not at all incapacitate the patient and that, should the individual so operated upon at any future time desire it an operation can be performed resexing him and making him potent as before.* But he added that the castration of an individual is a major operation that renders the subject without desire for sexual intercourse. And he testified that the castration of an individual might have a serious detrimental effect upon the patient.

From the record before us we conclude that the vasetcomy of a feeble-minded person does not come within the meaning of the constitutional inhibition against cruel and unusual punishment.

Inasmuch as a feeble-minded person may have become so afflicted by reason, perhaps, of some unfortunate accident, it then, under the act in question, becomes the duty of the examining board to diligently inquire into and carefully review the status of each case to determine whether the individual so examined has an acquired or a congenital or hereditary form of feeble-mindedness and whether such individual shall be sterilized as a condition prerequisite to his release from a State institution for the feeble-minded.

Public Welfare Justifies Exercise of Power

Buck v. Bell, 143 Va. 310, is a case wherein the court held that the sterilization act is not repugnant to the provi-

---

*Possibly in Nebraska. Not generally elsewhere. 50 per cent success claimed, 25 per cent probably nearer the truth.—EDITOR.

sions of the State and Federal constitutions. The court there said: "The act is not a penal statute. The purpose of the Legislature was not to punish, but to protect the class of socially inadequate citizens named therein from themselves, and to promote the welfare of society by mitigating race degeneracy and raising the average standard of intelligence of the people of the State." The Buck case was affirmed by the Supreme Court of the United States, and the rule was there announced that the failure to extend the provision of the act to persons outside the institutions named did not render the act obnoxious. Buck v. Bell, 274 U. S. 200.

In Massachusetts the court held that it was within the police power of the State, and not in derogation of the rights of any person, under the Fourteenth Amendment of the Constitution, to enact a compulsory vaccination law for the prevention of smallpox. Jacobson v. Massachusetts, 197 U. S. 11. And, in Washington the court there held, in the case of one convicted of rape, that vasectomy is not cruel punishment and that the operation could be painlessly performed in a few minutes. State c. Feilen, 70 Wash. 65.

In respect of the police power as pertaining to the affairs of the public generally, Mr. Justice Post said this:

"The essential quality of the police power as a government agency is that it imposes upon persons and property burdens designed to promote the safety and welfare of the public at large." Chicago B. & Q. R. Co. v. State, 47 Nebr. 549.

The legislative act before us is in the interest of the public welfare, in that its prime object is to prevent the procreation of mentally and physically abnormal human beings. We think it is within the police power of the State to provide for the sterilization of feeble-minded persons as a condition prerequisite to release from a State institution.

—Joseph Rossman.

How We Grow Up

INFANCY AND HUMAN GROWTH, *by* Arnold Gesell, Director, the Yale Phycho-Clinic. Pp. 410. Price $3.50. The MacMillan Company. 1928.

COMMENCING with an introductory glance at the total cycle of mental growth so as to suggest the close relationship between the psychological and biological aspects of developmental problems, Dr. Gesell deals in succeeding chapters with individual studies of a widely diversified group of infants and young children whose behavior he investigated comparatively at periodic intervals. Questions upon which he throws considerable light are: how fundamental is the interdependence between development and duration? Is there a stable substratum of maturation which governs the growth of the infant? How far do nutritional, environmental and conditioning factors enter into the complex of growth? The broad problem of heredity in relation to mental growth is considered in Part III which deals with the significance of human infancy.

While the orderliness of development in infancy is not so well recognized, that fact is shown to have great significance. Infants may differ in the manner in which they grow and every infant is shown to consist of a unique growth complex of biological, cultural, and medical factors never falling in the same pattern twice, yet there are certain basic uniformities in the dynamics of development which apply to all infants whether normal or abnormal, inferior or superior. Testing out the epigrammatic statement that prediction is the essence of science, our author found that in 80 per cent of the cases, the developmental rating made on the first examination corresponded to the final clinical estimate based on a total series of examinations. In general, early evidences of superiority are not so readily diagnosed as those of subnormality. Precocity, which seems to be a part of a child's biological endowment rather than an incident, is qualified further by the statement

that what retardation is to the inferior infant, acceleration is to the superior. Further, a close biological correlation exists between acceleration in this regard and intensification of behavior; indeed a two-month increment in infancy may approximate a two-year increment in late life. Often, however, the superiority of a given infant may become evident only when its total behavior picture is examined.

From the preceding, the reader will infer that Dr. Gesell finds some evidence of limitation on the explanation of behavior in motor terms, which argues for the value of dynamic concepts such a those of configuration or Gestalt. Mental growth, he says, tends toward an optimum realization. This life tendency, comparable to the evolutionary trend of the racial stream of life, tends toward harmony and completion in even a greatly handicapped child. Much light is thrown on this question by the author's studies of prematurely born infants. Here, he finds that the maturation of early behavior tends to follow in inherent genetic order, irrespective of the time of birth. The pre-term infant grows much like a foetus even though he is out of the womb. The infant is a habit forming creature even during the period of prematurity. The growth careers of both post-mature as well as premature infants strengthen the suggestion that inherent maturational factors determine the tempo of development whether birth is postponed or not. Thus, the pre-eminence of human infancy as compared with the simian lies in the prolongation and deepening of plasticity. The maturation of behavior patterns in the human infant proceeds with less rigidity, while the total behavior complex is suspended in a state of greater formativeness . This modifiability is highly sensitive to the social milieu; indeed the pre-eminent sociality of the child exists through the pre-language period long before the child has formed a single word. Herein lies humanity. It came late in the history of the race, but arrives early in the history of the individual.

Pointing out that the very essence of mental growth lies in a mixture of determinateness and indeterminateness, Dr. Gesell emphasizes his conception of the interdependence of heredity and environment as factors in the growth of the child. Tempo, trend and temperament are in large measure determined by hereditary factors, but the wealth of detail in the dynamic pattern we call personality is indeterminate until it is defined through experience. The concept of growth is seen to unite the tenets of these opposing schools, since it becomes necessary to consider conjointly the factors entering the shaping of the individual. Thus these factors should be thought of as being reciprocal, and interest then shifts to the conditions of development. Native endowment, then, does not come as discrete bequest, but is built up through a process of competion and selection among variable components.

In conclusion our author reminds us that the infant embodies life when it is in the most sensitive, the most responsive phase of growth. Small but fundamental alterations of his early nature, he believes, will project themselves throughout the entire life cycle. He predicts that through unremitting inquiry and measurement we shall eventually learn how to make wise alterations in the environment and he encourages us to believe that cherished human values will not suffer in this effort to control more systematically the course of individual growth.

N. M. Grier.

JOSEPH LANCASTER BUDD

(1835-1904)

TODAY scores of colleges have departments of genetics, and an institution of higher learning that did not present the science of heredity in its curriculum would be distinctly an anachronism. This is in contrast to the situation in 1876, when Professor Budd was appointed Professor of Forestry and Horticulture at Iowa State College. In this position he appears to have been the first teacher to give instruction in plant breeding as a college subject in any American Institution.

Professor Budd was a successful plant breeder himself, and did much to extend fruit culture into the Northwestern states. Realizing that hardier varieties were indispensable he went to Russia in 1882 to find and introduce varieties suitable for conditions in Iowa and the Dakotas. The material that he brought back from this trip has served as the basis for many of the varieties used in the Northwest and in Canada. It has been truly said that Professor Budd's efforts extended fruit-breeding farther north than any one man had ever extended it before. This expedition, the expenses of which were paid jointly by the Iowa Legislature and the Canadian Government, appears to have been the first governmentally financed plant introduction expedition that was ever sent out from America. Thus at their inception the close interrelation between plant breeding and plant introduction was epitomized by Professor Budd—first plant breeder and first plant explorer.

In his earlier years Professor Budd was a successful nurseryman; he amassed a modest fortune which enabled him to carry on the pioneering of his chosen work independently of financial worries.

R. A. Fisher Visits the U. S.

DR. R. A. FISHER, chief statistician of the Rothamsted Agricultural Experimental Station, Harpenden, England, is spending eight weeks in the United States during the present summer. He will be in residence on the staff of the Iowa State College during the first half of the Summer Session, June 16 to July 24 and later will visit a number of universities and research institutions throughout the country.

Dr. Fisher has made numerous fundamental and important contributions to the theory of statistics and the mathematics of biological experimentation. His most practical results have included the method of analysis of variance, the general use of degrees of freedom, and the wide extension of the exact treatment of small samples.

His most recent contributions have been in the development of a theory of efficient statistics in estimation, and a more adequate treatment of the mathematics of genetics. Readers of the JOURNAL OF HEREDITY will remember his book "The Genetical Theory of Natural Selection" reviewed by Dr. Sewall Wright in the August (1930) number of THE JOURNAL OF HEREDITY. Many will doubtless be familiar with his "Statistical Methods for Research Workers," which appeared in 1925 and is already in its third edition.

In connection with Dr. Fisher's visit the Iowa State College will give special emphasis this Summer Session to a group of courses covering the theory of statistics and their practical application in biology, economics, psychology, genetics, farm crops, and animal husbandry.

REVERSE GENOVARIATIONS*

And Gene Mutations in Different Directions

II. The Production of Reverse Genovariations in *Drosophila melanogaster* by X-Ray Treatment

N. W. TIMOFEEFF-RESSOVSKY

Genetische Abteilung des Kaiser Wilhelm Instituts für Hirnforschung Berlin-Buch, Germany

IN my preceding papers the significance of reverse genovariations in the problems of gene-structure is discussed[10,11]. In the preceding work I tried to produce somatic genovariations of the locus *W* (*white*-eye) in different directions by X-ray treatment of the fertilized eggs and young larvae of *Drosophila melanogaster*. I was proceeding on the assumption that in equal numbers of flies the probability of finding a somatic genovariation in eye color must be greater than that of a germinal one, since each fly has a great number of eye-facets, which are all independent of each other in the realization of eye colors in cases in which they contain different gene-combinations. These experiments gave positive results, but the technic of examination of the eye facets is so lengthy and difficult and the detection and identification of some eye colors in single facets is often so uncertain, that I came to the conclusion that work with somatic genovariations did not offer an advantageous point of attack. The work with germinal genovariations has a great advantage also in another way: germinal genovariations can be analyzed exactly through breeding experiments. Hence the work was continued only with germinal material.

In the previous work somatic genevariations of the *W* locus in different directions ($W>w$, $w>W$, $w^e>w$, $w^e>W$) and a germinal reverse genovariation of the gene *scute* were produced.[11] Hanson produced by X-ray treatment reverse variation of the *Bar* gene[1] and Muller obtained in his X-ray experiments reverse genovariations of the recessive sex-linked genes *scute* and *forked*.[5] My present X-ray work is proceeding in two directions: 1, production of genevariations in the *W*-locus in order to compare the stability of different *W*-allelomorphs and the rate of genovariation in different directions at this locus; 2, production of reverse genovariations in different, previously known loci in order to compare the "direct" and "reverse" rate of genovariations. In the present paper the results of the work upon production of reverse genovariations by X-ray treatment will be described.

Material and Methods

In order to determine which genes would give reverse variations it is of advantage to work with "multiple" stocks containing more than one or two recessive factors. We possessed the following "multiple" stocks: 1, X-chromosome — *yc$_v$vf, s$_c$w^{e}e$_e$ and X-plc* (*s$_c$ e$_e$ c$_t^6$ v g^2 f*) III—chromosome—*III ple* (*r$_u$ h s$_t$ p^p s$_s$ e^s*) and *"rucuca"* (*r$_u$ h t$_h$ s$_t$ c$_u$ s^r e^s c$_a$*†). Males from these stocks were X-rayed and then crossed with virgin females from the same stocks. Already in F_1 of these crossings the occurance of reverse genevariations (dominant) can be detected.

*Genovariation=gene-mutation.

†The characters designated by the symbols, and their locations are as follows: y—yellow, body-color, X-chr, 0.0; s$_c$—scute, bristles, X-chr. 0.1; w^e—eosin, eye-color, X-chr. 1; e$_e$—echinus, eye, X-chr. 5.5; c$_v$—crossveinless, wing veins, X-chr. 13.7; c—cut, wings, X-chr. 20.0; v—vermilion, eye-color, X-chr. 33.0; g^2—garnet, eye-color, X-chr. 44.4; f—forked, bristles,

Two X-ray dosages were used: 1, 50 kv., 5 ma., and aluminum filter 1mm. thick, target distance of 17 cm. and a length of treatment of 100 minutes; 2, 50 kv., 5ma., aluminum filter 1mm. trick, target distance of 15 cm. and a length of treatment of 45 minutes. The first of these dosages is somewhat heavier than the second, but no real difference in their effect in producing reverse gene-variations could be detected in our material.

X—Chromosome

The following males were X-rayed: 1, *white;* 2, *y* c_v *v f;* 3, s_c w_v e_c and 4. *X-ple.* The X-rayed males were crossed with virgin females from the same cultures. In F_1 from these crossings were obtained: 4439 *white*—females, 5172 *y* c_v *v f* females, 3186 s_c w^n c^e—females and 7819 *X-ple*—females. The results of these experiments are summarized in Table 1. The "multiple" stocks partly contain the same genes (s_c and e_c *v* and *f*); therefore in Table 1 the total numbers of females containing each given gene are summarized. In the last vertical column of the table is given the number of cases in which reverse genovariations occurred. The two questionable cases could not be analyzed since the females gave no offspring. Convincing cases of reverse genovariations, analyzed through further crossings are the following: $s^n > S_c$—3 cases among 11,005 flies examined; $w_v > W$—once among 4627 flies; $c_v > C_v$ once among 5172 flies and $f > F$—two cases among 1299 flies examined.

Of particular interest are the reverse genovariations of the genes s_c and *f* ($s_c > S_c$; $f > F$). The "direct" *scute*—genevariations ($S_c > s_c$) appeared once in our X-rayed cultures and in the X-ray work of Serebrovsky a number of s_c allelomorphs were produced.[7] This gene seems to be one that frequently mutates. The reverse genovariation ($s_c > S_c$) is apparently also comparatively frequent since, besides our three cases, it appeared twice in the X-ray work of Muller.[5] It is noticeable that genovariations of this locus in two different directions were produced by X-ray treatment. The same is true of *forked.* In the X-ray experiments of Muller this gene appeared several times[5] and in our experiments it appeared in two cases. The "direct" genovariations $W > w^e$ and $C_v > c_v$ were never found in our experiments, but Muller has mentioned them in the list of genes produced by X-ray treatment.[5]

III—Chromosome

Males from *III-ple-* and *"rucuca"*-cultures were X-rayed and crossed with virgin females from the same stocks. 6723 *III-ple* flies and 3237 *"rucuca"* flies were obtained in F_1 of these crossings. The genes r_u, *h*, s_t and e^s are present in both "multiple" stocks, so that the numbers of flies containing these genes are sums of F_1 flies from *III-ple* and *"rucuca"* crossings (Table II). Once among 9960 flies examined a reverse genovariation of hairy ($h > H$) was found. The "direct" mutation $H > h$ has, as far as I know, never been observed in X-ray experiments. Twice among 6723 flies the reverse genovariation $p^p > P$ was found. The direct genovariation $P > p^p$ (or $P > p$) appeared once among 1483 flies in crossings of X-rayed normal males with *III-ple* females.[11] In the same experiments there appeared also a second *p*-fly, but it was completely sterile, and probably contained a deficiency in the *p*-region. Thus in the *P*-locus genovariations in the two opposite directions were produced by X-ray treatment. Among the 9960 *sooty* (e^s) flies one female with normal body color was found (Table II), but this case was not analyzed, since the fly has given no offspring.

Conclusion

In summarizing all the above results we have the following: Reverse genovariations of four recessive sex-linked

X-chr, 56.5; r_u—roughoid, eye, III-chr. 0.0; h—hairy, hairs, III-chr. 26.5; t_h—thread, arista, III-chr. 42.2; s_t—scarlet, eye-color, III-chr. 44.0; p^p—peach, eye-color, III-chr. 48.0; c_u—curled, wings, III-chr. 50.0; s_s—spineless, bristles, III-chr. 58.5; s_r—stripe, thorax-color, III-chr. 62.0; e^s—sooty-color, III-chr. 70.7; c_a—claret, eye-color, III-chr. 100.7.

genes ($s^n>S_e$, $w^e>W$, $c_e>C^p$ and $f>F$) and two recessive genes located in chromosome III ($h>H$ and $p^p>P$) were produced by X-ray treatment. Hence in all the cases except $h>H$, genovariations of each locus in two opposite directions were produced by X-ray treatment.

The first conclusion which can be drawn from the results obtained in these experiments is the confirmation of the view that at least in some cases the genovariability is a reversible process. In connection with this it is evident that the genovariations are not merely "losses" or "absences" of previously present genes. Those cases, in which variations in opporite directions were produced by X-ray treatment are in confirmation of Muller's view that the X-rays have not a destructive but rather a reconstructive action upon the genes.[5]

Definite conclusions about the quantative relations between "direct" and "reverse" genovariations can not be drawn from the above results. In some ($S_e<>s_e$; $F<>f$; $P<>p^p$) the frequencies of variations in opposite directions seem to be of the same quantitative order, since all these genovariations were produced more than once and among approximately equal numbers of flies. The conditions in the W-locus are apparently quite different: the $W>w$ genovariation is one of the most frequently produced in X-ray experiments, its rate of occurrence being about 1 in 1000 flies;[5] but the reverse genovariation $w>W$ has as yet never been produced as a germinal mutation, although several thousands of *white* F_1 flies from X-rayed parents were examined. In experiments with somatic genovariations the $W>w$ change was repeatedly obtained after raying, its rate of occurrence being 1 in about 170 flies, or even one in about 100 flies;[6] the reverse somatic genovariation $w>W$ was observed only once, although 2986 X-rayed flies were examined.[11]

It is of great interest to search further for reverse genovariations in order to find out the stable and unstable allelomorphs of definite loci. Among the "mutated" allelomorphs there ought to be more chance of finding unstable genes than among the "normal" ones, because the most unstable allelomorphs must gradually disappear from the "normal" wild-type in the course of many generations in nature, unless they cause characters of high selective value.

Summary

Males from *white*, *y* c_e *v f*, s_e w^e e_e, *X-ple*, *III-ble* and "*rucuca*" stocks were X-rayed and crossed with virgin females from the same stocks. The F_1 flies from these crossings were examined in order to find reverse genovariations of these recessive genes. The following reverse genovariations were found: $s_e>S_e$ $w^e>W$, $c_e>C_e$, $f>F$, $h>H$ and $p^p>P$. The "direct" genovariations $S_e>s_e$, $W>w^e$, $C_e>c_e$, $F>f$ and $P>p^p$ were also produced by X-ray treatment (a part of them repeatedly) in Muller's experiments and ours, so that in these loci the X-rays can induce genovariations in two opposite directions.

Literature Cited

1. Hanson, F. B. 1928 The effect of x-rays in producing return gene mutations. *Science*, v. 67.

2. Morgan, T. H., Bridges, C. B., Sturtevant, A. H. 1925. The genetics of Drosophila. *Bibliogr. Genetica*, v. 2.

3. Muller, H. J. 1923. Mutation. *Eugenics, Genetics and the Family. Proceedings of Second International Congress of Eugenics.*

4. Muller, H. J. 1928. The problem of genic modification. *Verh. V Intern. Kongh. f. Vererb.*, v. 1.

5. Muller, H. J. 1928. The production of mutations by x-rays. *Proc. Nat. Acad. Sc.* (U.S.A.), v. 14.

6. Patterson, J. T. 1928. The effect of x-rays in producing mutations in somatic cells of Drosophila. *Science*, v. 68.

7. Serebrovsky, A. S. and others. 1928. The production of mutations by x-rays. *Journal de Biol. Exper.* (Russian), Ser. A, v. 4.

8. Timofeeff-Ressovsky, N. W. 1925. A reverse gene-variation in Drosophila funebris. *Journ. de Biol. Exper.* (Russian), Ser. A, v. 1; and *Genetics*, v. 12, 1927.

9. Timofeeff-Ressovsky, N. W. 1928. Eine somatiche Rückgenovariation bei Drosophila melanogaster, *Roux Arch. f. Entwmech.*, v. 113.

10. TIMOFEEFF-RESSOVSKY, N. W. 1929. The effect of x-rays in producing somatic gene-variations of a definite locus in different directions. *Amer. Nat.*, v. 63.

11. TIMOFEEFF-RESSOVSKY, N. W. 1929. Rückgenovariation und die Genovariabilität in verschiedenen Rechtungen. I. Somatische Genovariationen der Gene *W*, w^e und *w* bei *Drosopholia melanogaster* unter dem Einfluss der Röntgenbestrahlung. *Roux Arch. f. Entwmech.*, v. 115.

TABLE I—Reverse gene-variations of sex-linked characters in cultures, homozygous for these genes (F_1 from X-rayed flies)

Sex-linked genes	*Number of homozygous F_1 offspring from X-rayed flies*	*Number of reverse gene-variations*
y	5172	....
s_c	11005	3
w	4439	....
w^e	4267	1
e_c	11005	1?
c_v	5172	1
c_t^6	7819	....
v	12991	1?
g^2	7819	....
f	12991	2

TABLE II—Reverse gene-variations of III chromosome-characters in cultures, homozygous for these genes (F_1 from X-rayed flies)

III chromosome genes	*Number of homozygous F_1 females from X-rayed flies*	*Number of reverse gene-variations*
r_u	9960	....
h	9960	1
t_h	3237	....
s_t	9960	....
p^p	6723	2
c_u	3237	....
s_s	6723	....
s_r	3237	....
e^s	9960	1?
c_a	3237	....

Self-sterility

BRIEGER, FRIEDRICH. Selbststerilität und Kreuzungesterilität. (Monographien aus dem Gesamtgebist der Physiologie der Pflanzen und der Tiere, No. 21.) Pp. 365 with 188 illus., price $8. Verlag von Julius Springer, Berlin, 1930.

THIS encylopedic digest of recent research on difficult fertilization, giving a summary on the most important papers and hundreds of references, will be invaluable to those interested in this field. While most of the work has been done on plants, 40 pages are given to animals (insects, snails, echinoderms, amphibians, and the like). The author concludes that the phenomena of self-sterility and incompatibility are much too diverse to be brought together in any one simple formula.

PAUL POPENOE.